PINEMAP Year 5 Progress Report 2
December 2015
Aim 1 (Silviculture & Ecophysiology)

This is the second Aim progress report for year 5 (covering activity from July 1, 2015- November 30, 2015). The information provided in these reports is used to track Aim-level outputs and outcomes over the course of the project and to fulfill NIFA reporting requirements.

The purpose of this report is to gather information on progress since the previous progress report in July 2015.

To streamline this process, information reported in July 2015is provided below, so you will simply need to review and update each section as necessary.

Please return the completed report to Grace no later than December 1st.

PROGRESS SUMMARY:

Please provide 1-3 paragraph summary of key areas of progress since June 30, 2015. You might consider writing this section after completing the remaining sections.

OUTCOMES/IMPACTS

Outcomes and ***Impacts*** are tangible results for stakeholders and society that the project has produced to advance on the societal challenge (e.g., ***changes in knowledge, actions, or conditions*** that result from project activities). Outcomes and impacts are similar, but impacts are typically longer-term; outcomes are used as a nearer-term proxy for impacts.

Describe how Aim-level activities, results, findings, techniques, or products contribute to project-level outcomes and impacts (e.g., changes in knowledge, actions, or conditions resulting from activities).

A narrative has been drafted below. Please modify or update as necessary.

Aim 1 activities contribute to project-level outcomes and impacts primarily through the establishment and measurement of carbon and nutrient pools and fluxes on a three-tiered monitoring network. The data generated from this network will quantify the climatic, soils, and management impacts on water use and carbon sequestration in planted pine ecosystems and provide data necessary for the Aim 2 team to build and verify stand- to regional-level models that simulate pine forest dynamics under varying climate. These data and simulations will form the core of the PINEMAP Decision Support System which will provide landowners and managers the tools necessary to make decisions about managing planted pine for increased water use efficiency, carbon sequestration, enhanced fertilizer efficiency, and resilience to altered disturbance regimes.

OUTPUTS

Outputs are activities, events, services, and products that reach people.

Products

Products include published or in press peer-reviewed publications; other written materials such as white papers, research summaries, fact sheets, or popular press articles; audio or video products; etc.

The lists below summarize products reported in the July 2015Progress Report (March 1, 2015-June 30, 2015)
Please update as necessary (including in press publications that are now published) and highlight in yellow any new products added to the list for the December 2015 Progress Report.

Peer-reviewed publications

Bartkowiak, SM, Samuelson, L., McGuire, MA and Teskey, R. 2015. Fertilization increases sensitivity of canopy stomatal conductance and transpiration to throughfall reduction in an 8-year-old loblolly pine plantation. *Forest Ecology and Management* 354:87-96.

Bell, DM, Ward, EJ, Oishi, AC, Oren, R, Flikkema, PG and Clark, JS. 2015. A state-space modeling approach to estimating canopy conductance and

associated uncertainties from sap flux density data. *Tree Physiology*, In press.

Domec, J-C, Ward EJ, Oishi AC, Palmroth S, Radecki A, Bell DM, Miao G, Gavazzi M, Johnson DM, King JS, McNulty SG, Oren R, Sun G, Noormets A (2015) Conversion of natural forests to managed forest plantations impacts tree response to climatic variable and affects negatively tree resistance to prolonged droughts. *Forest Ecology and Management* 355: 58-71. doi:10.1016/j.foreco.2015.04.012

Gonzalez-Benecke CA, Teskey RO, Martin TA, Jokela EJ, Fox TR, Kane MB, Noormets A (2015) Regional validation and improved parameterization of the 3-PG model for Pinus taeda stands. *Forest Ecology and Management* 361: 237–256. doi:10.1016/j.foreco.2015.11.025

Lin W, Noormets A, King JS, Sun G, McNulty SG, Domec JC (2015) An update to a high-throughput α-cellulose extraction method for δ13C and δ18O stable isotope ratio analysis in conifer tree rings. Tree Physiology. Submitted.

Noormets A, Nouvellon Y (2015) Introduction for special issue: Carbon, water and nutrient cycling in managed forests. *Forest Ecology and Management* 355: 1-3. http://dx.doi.org/10.1016/j.foreco.2015.08.022

Noormets A, Epron D, Domec JC, McNulty SG, Fox TD, Sun G, King JS (2015) Effects of forest management on productivity and carbon sequestration: a review. *Forest Ecology and Management* 355: 124-140. http://dx.doi.org/10.1016/j.foreco.2015.05.019

Pile, L. C.A. Maier, G.G. Wang, D. Yu, T.M. Shearman. 2016. Response of two genetically superior loblolly pine clonal ideotypes to a severe ice storm. *Forest Ecology and Management* 360: 213-220.

Reinhardt K., M. Germino, L. M. Kueppers, J.C. Domec, J. Mitton. 2015. Linking carbon and water relations to drought-induced mortality in Pinus flexilis seedlings. Tree Physiology, In press.

Tian, S., Youssef, M.A., Sun, G., Chescheir, G.M., Noormets, A., Amatya, D.M., Skaggs, R.W., King, J.S., McNulty, S., Gavazzi, M., Miao, G., Domec, J.-C., 2015. Testing DRAINMOD-FOREST for predicting evapotranspiration in a mid-rotation pine plantation. Forest Ecol Manag, In press. http://dx.doi.org/10.1016/j.foreco.2015.03.028

Vogel, J.G., He D., Jokela E.J., Hockaday W., and Schuur E.A.G. 2015. The effect of fertilization levels and genetic deployment on the isotopic signature, constituents, and chemistry of soil organic carbon in managed loblolly pine *(Pinus taeda L.)* forests. Forest Ecology and Management.

Ward EJ, Domec JC, Laviner MA, Fox TD, Sun G, McNulty SG, King JS, Noormets A (2015) Fertilization simulates drought. Water use and stomatal conductance of loblolly pine (*Pinus taeda*) in a factorial fertilization and throughfall reduction experiment. *Forest Ecology and Management* *355*: 72-82. doi:10.1016/j.foreco.2015.04.009

Will, R.E., T.R. Fox, M. Akers, J-C Domec, E. Jokela, M. Kane, M.A. Laviner, G. Lokuta, D. Markewitz, M.A. McGuire, C. Meek, A. Noormets, L. Samuelson, J. Seiler, B. Strahm, R. Teskey, J. Vogel, E. Ward, J. West, D. Wilson, T. Martin. 2015. A Range-wide experiment to investigate nutrient and soil moisture interactions in loblolly pine plantations. Forests 6*:* 2014-2028; doi:10.3390/f6062014

Theses/Dissertations

None reported in July 2015

Pell, C.J., 2015. The effects of fertilization and four years of throughfall reduction on leaf physiology of loblolly pine (*Pinus taeda* L.). M.S. Thesis. December 2015. Auburn University.

Other publications

Subedi P., Jokela E.J., Martin T.A., and Vogel J.G. 2015. Effects of fertilization and weed control on second rotation growth and soil nutrient availability in juvenile loblolly pine plantations in North Florida. pp 249-251. *In* Holley, A. G.; Connor, K. F.; Haywood, J. D., eds. 2015. Proceedings of the 17th biennial southern silvicultural research conference. e–Gen. Tech. Rep. SRS–203. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 551 p.

Audio/video products

None reported in July 2015 report

Events/Activities

Events/activities include presentations (oral and poster) given at meetings or conferences; workshops/trainings/courses conducted; and experiments/surveys/data collection conducted.

The table(s) below summarize products reported in July 2015Progress Report (March 1, 2015-June 30, 2015)
Please update as necessary and highlight in yellow any new products added to the list for the December 2015 Progress Report.

Presentations

Author(s)/Presenter(s)	Title	Type	Date	Venue/Location
Albaugh, T.J. and T.R. Fox	Improving our understanding of growth differences of *Pinus taeda* in the United States and Brazil: A common garden experiment	Oral Presentation	June 10, 2015	33rd Southern Forest Tree Improvement Conference Meeting, Hot Springs, AR
Albaugh, T.J. and T.R. Fox	Growth of Pinus taeda in the US and Brazil: Understanding growth and carrying capacity differences	Oral Presentation	May 12, 2015	Forest Productivity Cooperative US Pine Working Group Contact Meeting, Florence, SC
Albaugh, T.J., T.R. Fox, M. Sumnall, R.A. Rubilar, C.A. Alvares, J.L. Stape	Growth of Pinus taeda in the US and BR: Will crown ideotype help determine optimum varietal silviculture?	Oral Presentation	March 4, 2015	18th Biennial Southern Silvicultural Research Conference, Knoxville, TN
Akers, M., Will, R., Samuelson, L., Fox, R., Jokela, E., Gonzalez, C., and Zhai, D.	Early growth results from the PINEMAP loblolly pine throughfall manipulation x fertilization study.	Poster Presentation	March 4, 2015	18th Biennial Southern Silvicultural Research Conference, Knoxville, TN
Bartkowiak SM, Samuelson	The Effect of Throughfall Reduction and Fertilization on Water Use	Poster	June 3, 2015	PINEMAP Annual Meeting, Athens, GA

LJ, McGuire MA, Teskey RO	in Loblolly Pine Over Two-Years at the Georgia Tier III Installation	Presentation		
Bruce B. Souza; Eric Ward, Lisa Samuelson, Stan Bartkowiak, Carlos Gonzalez Benecke, Robert O' Teskey	Estimating transpiration and growth efficiency in loblolly pine (Pinus taeda) plantations using the 3-PG model	Poster Presentation	March 2-5, 2014	18th Biennial Silvicultural Research Conference
Bruce B. Souza; Eric Ward, Lisa Samuelson, Stan Bartkowiak, Carlos Gonzalez Benecke, Robert O' Teskey	Estimating transpiration and growth efficiency in loblolly pine (*Pinus taeda*) plantations using the 3-PG model	Poster Presentation	June 3, 2015	PINEMAP Annual Meeting, Athens, GA
Domec, J-C, Noormets, A, King, JS, McNulty, SG, Sun, G, Palmroth, S, Radecki, A, Ward, EJ, Oishi, AC, Johnson, D, and Bell, D.	Conversion of natural forests to managed forest plantations decreases tree resistance to prolonged droughts.	poster	April 28, 2015	Dept. of Energy Terrestrial Ecosystem Science Meeting. Potomac, MD
Domec, J-C, Ward EJ, Oishi AC, Palmroth S, Radecki A, Bell DM, Miao G, Gavazzi M, Johnson DM, King JS, McNulty SG, Oren R, Sun G, Noormets A	Conversion of natural forests to managed forests and its effect on water balance, transpiration and resistance to drought across different scales	oral presentation	March 4, 2015	18th Biennial Southern Silvicultural Research Conference, Knoxville, TN
Johnsen, K. C.A. Maier, P. Anderson, R. Oren	Coarse root biomass of a 28 year-old *Pinus taeda* stand following carbon dioxide enrichment with and without nitrogen fertilization	oral presentation	March 4, 2015	18th Biennial Southern Silvicultural Research Conference, Knoxville, TN
Maggard, Adam O., R.E. Will, D.S. Wilson, C.R. Meek	The effects of decreased water availability on loblolly pine (*Pinus taeda* L.) productivity and the interaction between fertilizer and drought.	Oral Presentation	March 4, 2015	18th Biennial Southern Silvicultural Research Conference, Knoxville, TN
Maier, C.A. , D.McInnis, P.	Soil CO2 evolution, organic matter, and root development in newly	Poster	March 4. 2015	18th Biennial Southern Silvicultural

Anderson, P. Dougherty, K. Johnsen.	planted loblolly pine plantations			Research Conference, Knoxville, TN
Maier, C.A., P. Dougherty, K. Johnsen, M. Tyree	Quantifying genotype x silviculture interactions on productivity and carbon allocation by msnipulating soil organic matter, N supplt, and demand	oral presentation	November 16, 2015	2015 Soil Science Society of America Meeting, Knoxville, TN
McElligott, K.M., Strahm, B.D., Seiler, J.R.	Fertilization and Throughfall Reduction Affect Litter Quality and Extracellular Enzyme Activity	Oral Presentation	November 16, 2015	2015 Soil Science Society of America Meeting, Minneapolis, MN
Pell, C.J., L.J. Samuelson, M,K. Akers	Preliminary Three Year Analysis of Throughfall Reduction and Fertilization on Leaf Physiology of Loblolly Pine in Georgia	Poster Presentation	June 3, 2015	PINEMAP annual meeting, Athens GA
Pell, C.J., L.J. Samuelson, M.K. Akers, M. Kane, M.A. McGuire, R.O. Teskey, D. Markewitz, T. Stokes, S. Bartkowiak	Effects of fertilization and three years of throughfall reduction on leaf physiology of loblolly pine	Oral Presentation	March 4, 2015	18th Biennial Southern Silvicultural Research Conference. Knoxville, TN
Pile, L., C.A. Maier, G. Wang, T. Shearman, D. Yu	Responses of two genetically superior loblolly pine genotypes to a severe ice storm	poster presentation	March 4, 2015	18th Biennial Southern Silvicultural Research Conference, Knoxville, TN
Ward, E.J., J.-C. Domec, M.A. Laviner, T.R. Fox, G. Sun, S. McNulty, J.S. King and A. Noormets	Fertilization intensifies drought stress: Water use and stomatal conductance of Pinus taeda in a midrotation fertilization and throughfall reduction experiment.	Poster	August 14, 2015	Ecological Society of America Annual Meeting. Baltimore, MD.
Vogel, J.G.	Carbon and Nitrogen Pool Estimates from the Tier II Network	Presentation	June 3, 2015	PINEMAP annual meeting, Athens GA
Vogel, J.G.	'Getting there from here':Better forest growth predictions using PINEMAP data and modeling". 2015.	Presentation	May 19, 2015	Western Gulf Tree Improvement Program, College Station, TX.
Yang, J., C.M. Luedtke, M.K. Akers, M. McGuire, L. Samuelson,C. Pell, D.P. Aubrey, M. Kane and R.O. Teskey	Fertilization decreases soil CO_2 efflux and total belowground carbon flux in a loblolly pine plantation	Oral Presentation	March 3-4, 2015	18th Biennial Southern Silvicultural Research Conference. Knoxville, TN

Yang Jinyan, C M. Luedtke, K. M. Akers, Mary Anne McGuire, C. Pell, D. P. Aubrey,M. Kane, Robert O. Teskey	Fertilization decreases soil CO2 efflux and total belowground carbon flux in a loblolly pine (Pinus taeda) plantation	Poster Presentation	June 3, 2015	PINEMAP annual meeting, Athens GA
Yang Jinyan, C.M. Luedtke,K.M. Akers, Mary Anne, McGuire, L.J. Samuelson,C.Pell, R. Teskey	Effects of throughfall reduction and fertilzation on soil CO2 efflux and total belowground carbon flux in a loblolly pine plantation	Oral presentaion	August, 2015	100th ESA Annual meeting, Baltimore, Maryland

Trainings, workshops, and courses

None reported in July 2015 report

Experiments, surveys, and data collection

Title	Time Frame	Description
Tier I Legacy Experiments	Ongoing	The Tier I legacy network consists of hundreds of existing silviculture experiments and growth-and-yield plots that blanket the region and provide extensive, spatially explicit information on regional variability and productivity. Industry/university cooperative research installations to include in the Tier I legacy experiments have been identified and archived data from these sites has been uploaded into the TerraC database.
Tier II Active Experiments	Ongoing	The Tier II active experiments network consists of 127 sites distributed throughout the Southeast. These sites were selected to represent the range of climate, geology, and soil conditions in the Southeast and span a range of plantation ages (5 to more than 25 years) covering a progression of stand development. Principle treatments represented in the network include planting density, thinning, fertilization, and competition control. Sampling on all or a subset of locations in this network include biomass and carbon inventory; soil sampling; tree canopy light interception measurements; wood core sampling for $^{13}C/^{18}O$ analysis to determine water use efficiency; and assessments of soil carbon emissions, nitrous oxide emissions, and nitrogen uptake efficiency. Data collection from Tier II sites is ongoing.
Tier III Throughfall Exclusion x Fertilization Experiments	Ongoing	The Tier III throughfall exclusion x fertilization network is made up of four research sites situated at the edges of the native range of loblolly pine. The four sites, located in McCurtain County, Oklahoma; Taylor County, Florida; Taliaferro County, Georgia; and Buckingham County, Virginia, capture the current range-wide variability of climate, precipitation, and productivity (Figure 3). The research sites range in planting date from 2003 to 2008, are unthinned, and were planted with a mix of genetic sources appropriate for each region. Treatments at the four Tier III sites consist of a factorial experiment: • Control (no treatment) • Fertilizer: fertilizer additions to achieve "optimum" nutrition • Throughfall exclusion: panels installed in understory to divert 30% of throughfall off the plot • Fertilizer + throughfall exclusion: combined fertilizer and throughfall exclusion treatment Researchers at each Tier III site are measuring tree and stand growth, above and below ground carbon, changes in soil nutrient and water

		availability, whole-tree water use, leaf area development and canopy light capture, and soil carbon dioxide (CO_2) efflux (partitioned into autotrophic and heterotrophic respiration).

PROGRESS NARRATIVE

Provide a brief summary of progress on each deliverable/task/input/output listed below. Please provide a *brief* summary of progress on each deliverable/task/input/output listed below. In many cases, a one sentence summary may suffice. If there is no progress update on an item, leave blank. Please do not include any figures or tables, but please do include quantifiable measurements, if available (i.e., # of plots measured, # of samples, # of runs, # of people reached, etc.)

Text below summarizes products reported in the July 2015Progress Report (March 1, 2015-June 30, 2015). Older entries are grey

Please update as necessary and highlight in yellow any new products added to the list for the July 2015 Progress Report, with approximate month of estimated completion.

Net Ecosystem Productivity (section added during June 2015 meeting)

Deliverable: NPP Calculation (5/31/15)

NPP of the appropriate sites was calculated using measured diameter and heights and the appropriate allometric equations.

Input: Soil Ra/Rh (8/31/15)

Data are being collated across Tier II and Tier III sites

Task: Calculate treatment effects on NEP, analyze data (8/31/15)

Extended to 3/31/16

Task: Write manuscript (11/30/15)

Extended to 6/30/16

Task: Translate into response related to ecosystem C and C accounting, validate/extrapolate w/ tier II? (11/30/15)

Deliverable: Submit manuscript (2/29/16)

Deliverable: Factsheet, videos for general public on C measurement, why NEP is important (2/29/16)

Deliverable: Inclusion of NEP into DSS, models, outreach to landowners (post-PINEMAP, NCE)

Sap Flux Regional Analyses

Deliverable: 2013 GA, VA analyses (8/31/14)

Update: VA and GA manuscripts accepted for publication (6/13/2015)

FL analyses deliverable moved back to 8/31/15 goal during annual meeting June 2015.

Spreadsheet developed and data from all sites being entered in TerraC.

Task: Initial meeting on improving LAI (11/30/14)
A conference call was held to discuss LAI measurements to standardize across sites.

Task: Data through 9/30/14 in TerraC with LAI corrections (12/1/14)
Data submitted to University of Florida and is being input into TerraC.

Task: Standardize sapwood calculation radial corrections (2/28/14)
Protocols for carbon sampling, tree core collection, biomass sampling, precipitation collection for isotopes, GHG flux, and heterotrophic and autotrophic soil respiration, and IPAR-LAI protocols have been finalized and uploaded to the PINEMAP intranet site where they will serve as a reference for field work and data collection on Tier II and III sites. Standardized metadata and spreadsheets have been created. Radial corrections estimated for Florida in M. Wightman's M.S. thesis and for GA based on two depths in Bartkowiak M.S. thesis. Data collected in one tree per plot for other sites in growing season 2014, will be analyzed for cross-site analyses.

Deliverable: OK gas exchange, growth, and EC daily (5/31/15)
Data are being analyzed and a manuscript prepared. Deliverable moved back to 12/31/15.

Deliverable: OK VPD relationship (8/31/15)
Data are being analyzed.

Task: LAI Phenology from Remote Sensing (8/1/15)
New task added during June 2015 meeting.
Data are being analyzed.

Output: Soil moisture assessment and standard index (8/31/15)

New output added during June 2015 meeting.
Data are being analyzed.

Input: Ec monthly estimate to Aim 2 (11/30/15)
New input added during June 2015 meeting. Old item was an output due 2/28/15: Independent estimates from GA and VA sites currently being used to develop models. Standardized estimates for cross site analysis awaiting all relevant data streams to be available in TerraC.
Modeling framework and base code published in Ward et al. (2015) and Bell et al. (2015).
GA and VA data are being compiled with common modeling framework by Jan 1 2016. OK and FL to follow.

Task: Data through 9/30/14 in TerraC (12/1/15)
Sapflux data have been submitted as of 6/10/14.

Task: Data through 9/30/15 in TerraC (12/1/15)
New task added during June 2015 meeting.

Output: Ec monthly through 9/30/15 (2/29/16)
New output added during June 2015 meeting.

Deliverable: Final cross-site analysis of E_C, G_S (2/29/16)
Modeling framework and base code published in Ward et al. (2015) and Bell et al. (2015).

Task: Loblolly branch and root hydraulic characterization Tier III sites (post-PINEMAP)
Hydraulic conductivity and cavitation vulnerability of branches and small coarse roots to be determined for all Tier III sites. To be linked to results from cross-site sap flux analyses.

Protocol developed and 1 branch sample per plot analyzed for VA site.

Task: Loblolly pine water use and stress characterization at VA Tier III (post-PINEMAP)
Loblolly pine needle water potential characteristics, terminal stem hydraulic conductance and foliar stable carbon isotope ($\delta^{13}C$) discrimination are being monitored at the VA Tier III site. Characterization of fine root distribution to 15 cm in response to throughfall treatments is ongoing. Preliminary analysis indicates a strong redistribution of fine roots into open areas and away from throughfall exclusion zones. Needle level gas exchange in response to changes in VPD are being determined at VA Tier III site. Results from the first field season are being analyzed. A greenhouse study is being planned that will examine initial tree response to strong spatial gradients in soil water content.

Deliverable: (Duncan) Input into DSS water portal (post-PINEMAP)
Deliverable added during June 2015 meeting

Soil respiration regional analysis

Output: R_S to modeling via existing (8/31/14)
Completed via Templeton et al. (2015) paper

Output: R_H/R_S to modeling via Tier III synthesis (11/30/14)
Sampling and analysis has been completed for the VA, OK, and FL Tier III sites. Results have been delivered to modeling. Addition work at Tier III sites is ongoing, including further validation. Specifically, at the GA Tier III installation, measurements were made of soil CO_2 efflux and its components—autotrophic CO_2 efflux, heterotrophic CO_2 efflux and CO_2 efflux from the ectomycorrhizal hyphae.

Output: R_H/R_S to modeling via Tier II synthesis (2/28/15?)
Ongoing analyses of variation in Rh:Rs partitioning coefficient as related to age, fertilization, weed control, seasonality, clonal variation, and

planting density.

Sampling of R_H/R_S is ongoing across the Tier II network in order to validate and inform observations from the Tier III synthesis.

At least three Tier II sites in each sub-region were identified for Rh vs. Ra measurements using the established PINEMAP protocol. Equipment has been installed for late summer measurements.

Input: DayCent sensitivity analysis from modeling (2/28/15)

DayCent has been calibrated at tier 3 sites using available measured data, specifically NPP. Validation efforts for tier 3 sites are underway before the model can be regionalized.

Task: R_S validate (2/28/15)

A region-wide dataset of R_S has been reanalyzed. A four-parameter model (temperature, temperature x moisture, bulk density, soil nitrogen) explains 56% of the variance in R_S. A simple one-parameter model (temperature) explains 48% of the variance in R_S. Multiple datasets from across the region are being combined and analyzed to validate and further current models.

Task: R_H/R_S further exploration (2/28/15)

A study to investigate how R_H:R_S changes with stand age and season installed in central Virginia within the Appomattox-Buckingham State Forest (close to the Tier III installation) has been completed. Three replications of four loblolly pine age classes (2-3, 7-9, 16-18, and 23-25 years-old) were measured using established PINEMAP protocols. Sites are extensively managed with no fertilization or weed control. Preliminary analysis indicates a significant stand age effect with annual R_H:R_S decreasing with age. Annual R_H:R_S (excluding winter) by stand age: 3=0.69, 9= 0.67, 18=0.57, 25=0.59.

A study to investigate how soil microbial processes and litter chemistry are linked to decomposition established at the Virginia Tier III site

has been completed. Data collected from this study include soil CO_2 efflux, leaf litter structural carbohydrate and lignin content, soil (0-10 cm) nutrient content, litter and soil microbial and extracellular enzyme activity, and macroinvertebrate abundance and diversity. Results show that throughfall reduction and fertilization alter lignin:nutrient ratios, and extracellular enzyme activity response to fertilization differed by horizon but generally show a shift from N- and P-mineralizing enzyme activity to C-mineralizing activity.

A study investigating the contribution of O horizon CO_2 efflux to R_S using forest floor collected Virginia Tier III site has been completed. Preliminary results suggest the O horizon can contribute to more than 50% of total efflux following wetting events but very little (near zero) when dry.

Deliverable/output: R_S, and R_H/R_S (variation vs space and stand condition) confirmation to modeling (8/31/15)
(due date moved from 5/31/15 during June 2015 meeting)

- Validation of Templeton's Rs model with continuous observations (confirmation during June 2015 meeting, paper due date ~~9/15/15,~~ 12/31/15)
- Comprehensive synthesis of sources of variability in Rh:Rs ratio. Work is ongoing, target date for delivery to modelers: Dec 31, 2015. (this is essentially "***Task: Rh:Rs Tier 2 synthesis (11/30/15)***" below)

Task: collect existing info – synthesize soil health and R_H data (8/31/15)
Task added during June 2015 meeting

Input: Help from Extension to frame factsheets (8/31/15)
Input added during June 2015 meeting

Task: Rh:Rs Tier 2 synthesis (11/30/15)
Markewitz, Brown. Preliminary results to modelers (9/1/15). Task added during June 2015 meeting.

Task: Rh:Rs Tier 3 synthesis (11/30/15)
Strahm and Seiler have completed analysis for the Tier III synthesis and are currently drafting the associated synthesis paper.

Outreach Deliverable: 1 (2/29/16)
Flexible forest management for multiple ecosystem services and soil health – Maier. Deliverable added during June 2015 meeting.

Outreach Deliverable: 2 (2/29/16)
Fact sheets, case studies to outline in detail each forest management of deliverable 1 above (McElligott, Minor). Deliverable added during June 2015.Document is currently being drafted.

Tier II regional analyses

Input: Tier II inventory extracted from Tier I (8/31/14)
Extractions of soil properties (n=18) from the Soil Survey Geographic (gSSURGO) Database and climate data (PRISM and Idaho Geospatial has been completed for tier I and II sites. Extractions of MACA climate data are ongoing since MACA data just recently were compiled.

Task: Bulk density pedotransfer functions (8/31/14)
Approach is under development

Task: Bulk density variation PINEMAP NRCS (11/30/14)
This deadline is dependent on the next item but will likely be met.

Output: Aboveground metrics to TerraC (11/30/14)

Field measurements are ongoing but this deadline will be met.

Deliverable: Complete field sampling (2/28/15)
Tier II field sampling is complete in the Auburn/UGA and Western Gulf sub-regions.

Deliverable: Complete ½ plots into TerraC (5/1/15)
This deadline is being extended.

Output: To modeling groups (5/1/15)
This deadline is being extended.

Deliverable: Bulk density papers (2/28/15)
More than 1200 direct observations of soil bulk density (Db) from the PINEMAP Tier II Network have been combined with more than 2700 direct observations in the southeastern United States from the National Cooperative Soil Survey. This extensive database is being used to create pedotransfer functions using Random Forest models with two goals in mind: (1) to predict missing Db values that are needed to estimate soil C and N contents of the Tier II installations, and (2) to understand the nature of variation and depth dependence of Db in forest ecosystems. Results from this modeling exercise will be compiled as a manuscript that will be submitted for publication by June of 2015.

A study designed to quantify the depth dependence and actual variability of Db at the plot level was established in North Florida in Dec 2014 and will be completed by May 2015. Soils from different taxonomic Orders (Spodosols and Ultisols) are being intensively sampled for Db (n=100) at each of four depths corresponding to the PINEMAP Tier II sampling depths (0-10; 10-20; 20-50; and 50-100 cm). A combination of traditional statistics and geostatics are being conducted to quantify Db uncertainty and our ability to accurately measure elemental contents of forest soils.

Task: Analysis and creation of functions (8/31/15)
Task added during June 2015 meeting.

Task: Finalize datasets (8/31/15)
Task added during June 2015 meeting.

Deliverable: Final analysis all plots (8/31/15)
This deadline will likely be met.

Output: Interacting with modeling groups (8/31/15)
This deadline will likely be met.

Deliverable: C analysis of existing data (Jason V./ Bacon) (11/30/15)
This deadline will likely be met.

Deliverable: DSS above and soil forest floor carbon and NUE, trace (Vogel, Fox) (11/30/15)
Deliverable added during June 2015 meeting

Input: LCA analysis C emissions from practice (11/30/15)
Input added during June 2015 meeting

Deliverable: Carbon upscaling kriging (Sabine) (2/28/16)
This deadline will likely be met.

Regionalize estimates of WUE for application in 3-PG and WaSSI (no date)
Grace says: does this belong somewhere else?

BROAD IMPACTS

Provide a short narrative describing broad impacts (i.e., far-reaching and possibly unanticipated outcomes resulting from PINEMAP work). Specifically, please highlight leveraged funds and/or partnerships with other projects/external collaborations.
No broad impact narrative has been provided.

TRAINING

A CUMULATIVE list of all Aim 1 undergraduate and graduate students, postdocs, and technical/research personnel trained under this project and descriptions of their research focus and/or role in the project is provided below. Additions/ changes made in the July 2015 progress report are highlighted in blue. Please update as necessary and highlight in yellow any updates made for this progress report.

Last name	First name	Position	University	Role
Akers	Madison	Research Staff	UGA	Coordinating baseline measurements on Tier II sites and overseeing installation and data collection on the Georgia Tier III site
Albaugh	Tim	Research Staff	NCSU	Evaluating impacts of weed control and fertilization on loblolly pine using the 3-PG model
Alvarez	Jose	Postdoc	NCSU	Evaluating changes in loblolly pine leaf area due to silvicultural treatments as a component of the 3-PG model
Ausmus	Casey	M.S. Student	OSU	Research focus: determine the effects of fertilizer and water availability on tree physiological processes
Bacon	Allan	Post-Doc	UF	Modeling regional and plot level controls on the central tendencies and uncertainties of soil bulk density and their implications to the chemical budgets of soils and forest ecosystems. Assisting in the regional analysis ecosystem carbon and nitrogen budgets across the Tier II Network.
Baggett	Brittany	Undergraduate Intern	Univ. of W. FL	2013 Undergraduate Fellow; working with Adam Maggard at OSU
Barringer	Hollie	Undergraduate Research Assistant	TAMU	Assisted in implementing carbon monitoring protocol
Barron	Stephan	Undergraduate Intern	Auburn	2014 undergraduate fellow; working with Stan Bartkowiak and Lisa Samuelson. Focus area: Sap flow and leaf/stand level physiology.
Bartkowiak	Stan	M.S. Student	Auburn	Research focus: measuring sap flux at the Georgia Tier III site

Bartkowiak	Stan	Research Staff	Auburn	Monitoring sap flux and canopy level processes at the Georgia Tier III site
Bass	Allison	undergraduate intern	UNC Wilmington/ NCSU	2014 undergraduate fellow; working with Wen Lin, and Michael Gavazzi. Focus area: Soil carbon dynamics
Brown	Robert	M.S. Student	UGA	Research focus: estimate proportion of heterotrophic respiration vs. autotrophic respiration of forest soils.
Clark	Joe	M.S. Student	Auburn	Research focus: assessing relationships among intercepted radiation, LAI, photosynthetic capacity, phenology, and productivity in loblolly pine
Clark	Zach	M.S. Student	UGA	Research focus: assessing developmental pattern of understory vegetation on Tier II installations
Cucinella	Josh	Research Staff	UF	Coordinating baseline measurements on Tier II sites and overseeing installation and data collection on the Florida Tier III site
Diamond	Amanda	Undergraduate Intern	VT	2013 Undergraduate Fellow; working with Madison Akers at UGA
Fang	Yuan	Ph.D. student	NCSU	TBCF at Bladen Lake Tier 2 site, and Rh:D analysis across Tier 3 sites
Faison	Andrew	Undergraduate Intern	VSU	2012 Undergraduate Fellow; assisted Jay Raymond at Virginia Tech with investigating the mechanisms nitrogen dynamics and uptake efficiencies of N containing fertilizers in loblolly pine plantations using stable isotope (15N) techniques.
Few	John	Undergraduate Intern	VSU	2013 Undergraduate Fellow; working with Asko Noormets at NCSU
Fields	Anthony	Undergraduate Intern	VSU	2013 Undergraduate Fellow; working with Maxwell Wightman at UF
Frye	Sam	Research Staff	VT	Assisting with soil CO2 efflux and N2O measurements and installation and data collection on Tier II and III sites.
Gonzalez	Carlos	Research Associate	UF	Ecophysiology and Carbon Balance Modeling; support of tree transpiration measurements for Tier III; use of 3PG model to assess the effect of climate change in productivity of loblolly pine plantations in SE U.S.
Gregory	Bethany	Undergraduate Intern	VT	2012 Undergraduate Fellow; helped Andy Laviner at Virginia Tech with a study on environmental manipulation of fertilization, drought, and thinning in loblolly pine plantations.
Hancock	Amanda	Undergraduate Research Assistant	TAMU	Carbon monitoring protocol implementation for Tier II sites.
Hardison	Alex	Undergraduate Intern	OSU	2014 Undergraduate Fellow; working with Adam Maggard at OSU
He	Dongmei	Visiting Chinese PhD student	TAMU	Effect of soil aggregrates on soil C stabilization in different families of loblolly pine

Heim	Brett	M.S. Student	VT	Research focus: separating heterotrophic and autotrophic respiration components of soil CO_2 efflux
Heinemann	Bob	Research Coordinator	OSU	Assists with site maintenance and data collection on Oklahoma Tier III site.
Holeman	Randy	Research Specialist	OSU	Assists with site maintenance and data collection on Oklahoma Tier III site.
Hurst	Kari	Research Technician	UF	Coordinates Tier III sap flux measurements and sap flux probe construction.
Ingwers	Miles	Ph.D. Student	UGA	
Jackson	Colin	Undergraduate Intern	OSU	2013 Undergraduate Fellow; working with Jay Raymond at VT
Jarvis	Rebecca	Undergraduate Intern	VT	2012 Undergraduate Fellow; assisted Wen Lin at North Carolina State University with quantifying the growth rate of loblolly pine, and analyze its sensitivity to temperature and precipitation dynamics.
K.C.	Dipesh	Postdoctoral Fellow	OSU	Tier III data inventory and TerraC database management
Kinnerly	Will	Undergraduate Intern	VT	2012 Undergraduate Fellow; helped Brett Heim at Virginia Tech with experimental manipulations of belowground metabolic activity in order to separate microbial respiration from plant respiration
Laguer Martinez	Doris	Undergraduate Intern	University of Puerto Rico	2014 Undergraduate Fellow; working with (Jill) Ji Qi at UGA; learned about forest soil carbon and hydrology
Laviner	Andy	Ph.D. Student	VT	Coordinating baseline measurements on Tier II sites and overseeing installation and data collection on VA Tier III site; research focus is water use efficiency in loblolly pine
Legendre	Manon	Undergraduate Intern	McGill University / NCSU	2015 PINEMAP intern, worked with Wen Lin. Measured and date tree cores from tier 2 sites, and processed soil samples for Rh:Rs partitioning at the Tier2 sites in the northern subregion.
Lewis	Wilson	Research Technician	UF	Assists with Tier III measurements and Tier II sample collection and lab processing
Lin	Wen	Ph.D. Student	NCSU	Research focus: water use efficiency in loblolly pine using 12C/13C ratios in wood
Luedtke	Cody	Ph.D. Student	UGA	Research focus: Soil CO2 efflux
Maggard	Adam	Ph.D. Student	OSU	Research focus: ecophysiology on Tier II and III sites
McElligott	Kristin	Ph.D. Student	VT	Research focus: mechanisms controlling total soil CO_2 efflux and heterotrophic and autotrophic soil respiration
Medsker	Teresa	M.S. Student	OSU	Research focus: belowground processes affected by fertilization and water availability
McConaghy	Scott	Undergraduate Intern	Kansas State	2013 Undergraduate Fellow; working with Yang Zhang at TAMU
Meek	Casey	Research Staff	OSU	Assisting with ecophysiological and process measurements at Tier II and III sites
Meeks	April	M.S. Student	NCSU	Incorporating competing vegetation in 3-PG model
Mitchell	Samuel	Undergraduate Intern	TAMU	Assisting graduate student in research

Nagel	Greg	Undergraduate Research Assistant	TAMU	Carbon monitoring protocol implementation at Tier II sites
Parisher	Josh	Undergraduate Research Assistant	TAMU	Carbon monitoring protocol implementation at Tier II sites
Pell	Charles	M.S. Student	Auburn	Research focus: ecophysiology at the Georgia Tier III site.
Pike	Jason	Research Staff	OSU	Assisting with installation, maintenance, and data collection on Tier III sites
Qi	Jill	Ph.D. Student	UGA	Research focus: soil water and deep soil carbon responses under rain throughfall treatment at Tier III sites
Raymond	Jay	Ph.D. Student	VT	Research focus is N uptake efficiency of enhanced efficiency N fertilizers using 15N stable isotopes
Russell	Ed	Ph. D. Student	VT	Research focuses on water relations at Tier III installations
Rutemiller	Paul	Undergraduate Intern	VT	2013 Undergraduate Intern; working with Chris Maier at the USFS
Ryland	Rachel	Undergraduate Research Assistant	UGA	Received training in field sampling of trace gases at the Georgia Tier III installation and has been trained in laboratory techniques for soil gas analysis on the gas chromatograph
SantaMaria	Tayler	Undergraduate Intern	Kenyon College / NCSU	2015 PINEMAP intern, worked with Wen Lin. Measured and date tree cores from tier 2 sites, and processed soil samples for Rh:Rs partitioning at the Tier2 sites in the northern subregion.
Seyle	Jacob	Undergraduate Research Assistant	NCSU	Assists with processing soil samples from Tier2 soil respiration plots in the northern subregion, makes sapflow probes for Tier 3 installations, analyzes growth responses of trees at Tier 2 sites to historic drought events. /AN/
Sherrod	Charles Allen	Undergraduate Research Assistant	UGA	Received training in field sampling of soil at the Georgia Tier III installation and has been trained in laboratory techniques for soil sample preparation and analysis
Shrestha	Raj	Postdoctoral Research Scientist	VT	Soil greenhouse gas (CO2, N2O, CH4) flux across soil moisture and management gradients
Barros	Bruce	M.S. Student	UGA	Research focus: Transpiration predictions with 3-PG model (Tier III)
Seyle	Jacob	Undergraduate Research Assistant	NCSU	Heterotrophic respiration, coarse woody decomposition, making sapflow probes for Tier 3 sites. /AN/
Stebler	Elaine	Research Staff	OSU	Coordinating baseline measurements on Tier II sites and overseeing installation and data collection on the Oklahoma Tier III site
Stokes	Tom	Research Staff	Auburn	Assisting with data collection on Tier II and III sites
Subedi	Santosh	Ph.D. Student	VT	Research focus: identifying an improved method to determine fertility rating for 3-PG

Thompson	Ian	Undergraduate Research Assistant	NCSU	Heterotrophic respiration, coarse woody decomposition, making sapflow probes for Tier 3 sites. /AN/
Vial	Sara	Undergraduate Research Assistant	VT / NCSU	2014 Undergraduate fellow, working with Wen Lin. Focus area: Radial growth and drought sensitivity in Tier2 sites.
Ward	Eric J.	Post-Doc	NCSU	Measuring and modeling forest water and carbon cycles, including quantifying uncertainty in key processes; working with both Aim 1 and 2 to integrate data and models such as 3PG and WaSSI-C across scales; assisting with data collection and analysis of water fluxes at the Virginia Tier III site.
Wightman	Maxwell	M.S. Student	UF	Research focus: Ecophysiology of drought response on FL Tier III site
Wigley	Madison	Undergraduate Research Assistant	TAMU	Carbon monitoring protocol implementation for Tier II sites
Wilson	Elizabeth	M.S. Student	TAMU	Research focus: understanding the effects of mesophyll conductance on isotopic signatures in leaves
Yancey	Fletcher	Research Technician	UF	Coordinates Tier III sap flux measurements and assists with Tier II sample collection and lab processing
Yang	Jinyan	Ph.D. Student	UGA	Research focus: Heterotrophic and autotrophic components of soil respiration
Zhai	Lu	MS	TAMU	Research focus: Family and culture effects on ecosystem C and N dynamics
Zhang	Yang	Ph.D. Student	TAMU	Research focus: Carbon and nitrogen cycling response to drought at the OK Tier III site